

SHIP PRODUCTION COMMITTEE  
FACILITIES AND ENVIRONMENTAL EFFECTS  
SURFACE PREPARATION AND COATINGS  
DESIGN/PRODUCTION INTEGRATION  
HUMAN RESOURCE INNOVATION  
MARINE INDUSTRY STANDARDS  
WELDING  
INDUSTRIAL ENGINEERING  
EDUCATION AND TRAINING

November 15, 2000  
NSRP 0579  
N4-94-1

# **THE NATIONAL SHIPBUILDING RESEARCH PROGRAM**

## **Capacity and Resource Analysis Model (CRAM)**

U.S. DEPARTMENT OF THE NAVY  
CARDEROCK DIVISION,  
NAVAL SURFACE WARFARE CENTER

in cooperation with  
Newport News Shipbuilding

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>15 NOV 2000</b>		2. REPORT TYPE <b>N/A</b>		3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>The National Shipbuilding Research Program, Capacity and Resource Analysis Model (CRAM)</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Naval Surface Warfare Center CD Code 2230-Design Integration Tools Bldg 192, Room 128 9500 MacArthur Blvd Bethesda, MD 20817-5700</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>SAR</b>	18. NUMBER OF PAGES <b>14</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

## DISCLAIMER

These reports were prepared as an account of government-sponsored work. Neither the United States, nor the United States Navy, nor any person acting on behalf of the United States Navy (A) makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness or usefulness of the information contained in this report/manual, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or (B) assumes any liabilities with respect to the use of or for damages resulting from the use of any information, apparatus, method, or process disclosed in the report. As used in the above, "Persons acting on behalf of the United States Navy" includes any employee, contractor, or subcontractor to the contractor of the United States Navy to the extent that such employee, contractor, or subcontractor to the contractor prepares, handles, or distributes, or provides access to any information pursuant to his employment or contract or subcontract to the contractor with the United States Navy. ANY POSSIBLE IMPLIED WARRANTIES OF MERCHANTABILITY AND/OR FITNESS FOR PURPOSE ARE SPECIFICALLY DISCLAIMED.



**Final Report**

**CAPACITY**  
and  
**RESOURCE**  
**ANALYSIS**  
**MODEL**

**SURVICE**  
ENGINEERING COMPANY

Bath Iron Works  
A GENERAL DYNAMICS COMPANY

# **Final Report**

## **Capacity and Resource Analysis Model**

**NSRP N4-94-1**

Submitted to

**The National Shipbuilding Research Program**

By

Valda Foye

New Business Planning

Bath Iron Works

November 2000



**Bath Iron Works**  
**A GENERAL DYNAMICS COMPANY**

# Table of Contents

<b>Section</b>	<b>Title</b>	<b>Page</b>
<b>1.0</b>	Introduction	4
<b>2.0</b>	Requirements	6
<b>3.0</b>	Development	8
<b>4.0</b>	Implementation and Testing	11

## 1.0 Introduction

The overall objective of this project was to develop an analytical tool to evaluate various production plan options across programs and determine the most efficient operational plan for shipyard resource and facility utilization. This model's intended use is three fold. Firstly aid shipyards in development preliminary build strategies during the strategic planning phase, secondly, update the build plans during the planning life cycle as the design matures, and finally, perform "what if" scenarios to identify capacity constraints as part of the operational planning process.

As shown in figure 1-1, shipyards typically perform planning functions at three different levels during the contract lifecycle:

**Figure 1-1**

Level	Planning Phase	Planning System
1	Strategic Planning	Various
2	Operational Planning	Master Schedule Network
3	Detail Planning	MRP/Shop Floor Control

Developing preliminary build strategies that integrate capacity, resource requirements, backlog, and potential workload has been a notable concern, and costly to shipyards. The ability to predict impact on ship construction costs and cycle times in accordance with changing shipyard conditions will lead to better resource allocation and facility utilization therefore, reduce cost.

This project addressed those concerns by developing a strategic planning tool that models the effects of potential schedule and facility changes on current resources and allows planners to cost effectively perform "what if" scenarios, evaluate potential workload, and gain better understanding of current processes. This *Capacity and Resource Analysis Model* (CRAM) gives users the ability to

develop custom “build strategies” for unique ship types considering resource requirements, facility availability, current backlog, and potential future production. The build strategies developed by CRAM will become road maps followed by the shipbuilder to maximize efficiency of facility and resource utilization.

Build strategies have traditionally been developed during the operational and detail planning phases where shipyards have invested considerable capital in information management systems. Unfortunately, this is too late in the planning process to properly assess shipyard capacity constraints and allow sufficient time to eliminate or mitigate major capacity issues. This situation leads to the development of a less than optimum production plan ultimately driving labor costs higher.

U.S. shipyards need the capabilities to quickly and efficiently assess business opportunities in the ship building market. It is very challenging for shipyards to select the right product mix that best compliments their facility and resource availability while meeting current customer schedule and cost requirements. Detail information associated with existing backlog and projected capacity requirements for potential new business integrated in a user-friendly system would be invaluable in the development of accurate business plans. CRAM is a tool shipyards could use to evaluate the best product mix that results in:

- Desired throughput at competitive costs
- Explore new markets without disruption of current programs and core business
- Maintain key ship building skills
- Better create “common” co-authored build plans

Shipyard Teaming arrangements could also benefit from CRAM. The flexibility of the tool will enable the development of “common” build plans to be co-authored then adapted to each shipyard’s facility and resource capabilities.

## 2.0 Requirements

The first task of this project was to define system requirements. CRAM was envisioned to be a shipyard wide strategic/tactical planning tool used for schedule, resource, and capacity planning. The following needs and scope were identified;

- Examination Of Schedule/Capacity Scenarios. - “WHAT IFS”

CRAM was designed with the dexterity to accommodate variables most likely to change during a shipbuilding program. Factors such as periods of no work, multiple changes in shift manning and reassignment of workstations can easily be added to CRAM to identify their impact to various scenarios.

- Rationalize Schedule, Facility And Resource Impact For Ease Of Communication To Essential Decision-Makers.

The information produced by the system must be transparent to a diverse group of interested parties. CRAM provides clear data in formats useful across the functional divisions and management layers of an organization.

- Credible Detail Coupled With Streamlined Performance.

CRAM offers reporting capability which furnishes all necessary detail while continuing to function in a streamlined manner. Users can expeditiously create multiple scenarios to consider a variety of options.

- Simplicity Of Data Mining.

CRAM features sufficient automation of data mining to maximize analysis time. In other words, users can spend the majority of their time examining impacts instead of developing inputs.

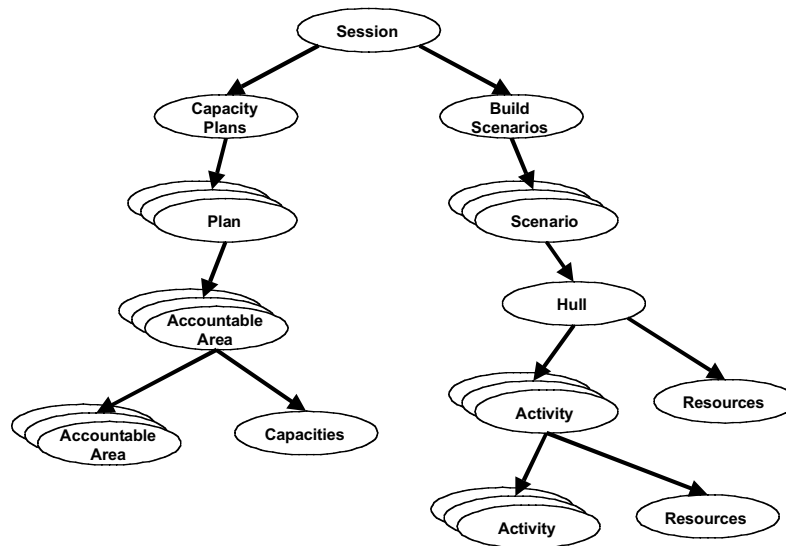
➤ Ease Of Integration

CRAM integrates smoothly with Master Scheduling and Budgeting/Finance functions to support robust schedule, capacity, and resource analyses.

It was determined that in order to meet the needs of analysts and planners the CRAM model had to be generalized for both capacity and resource analysis. It would also be necessary for the user to determine granularity, level of detail over time.

Figure 2-1 represents the CRAM Object Model developed to facilitate transition to Code Development.

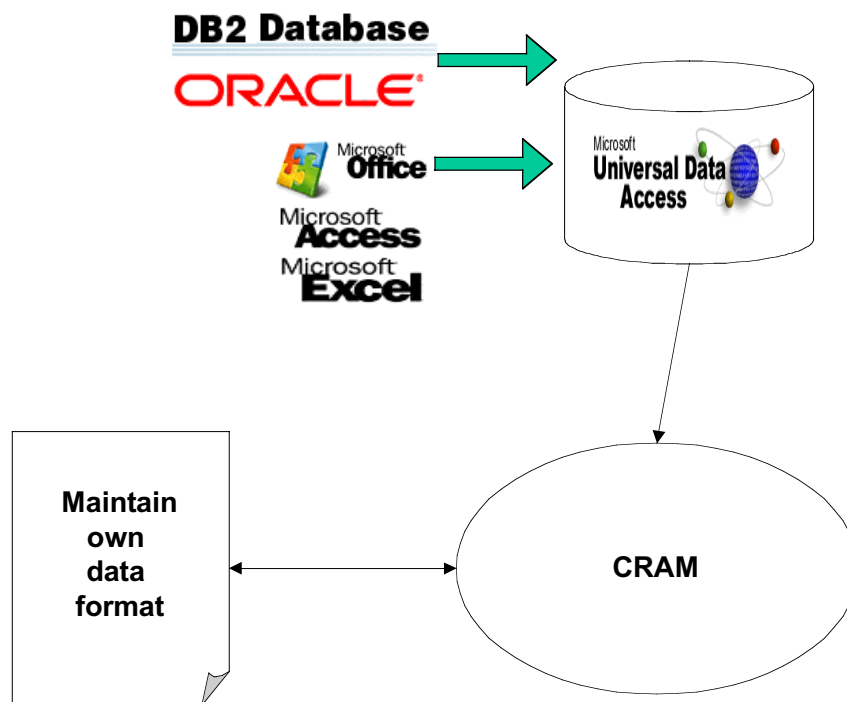
**Figure 2-1**



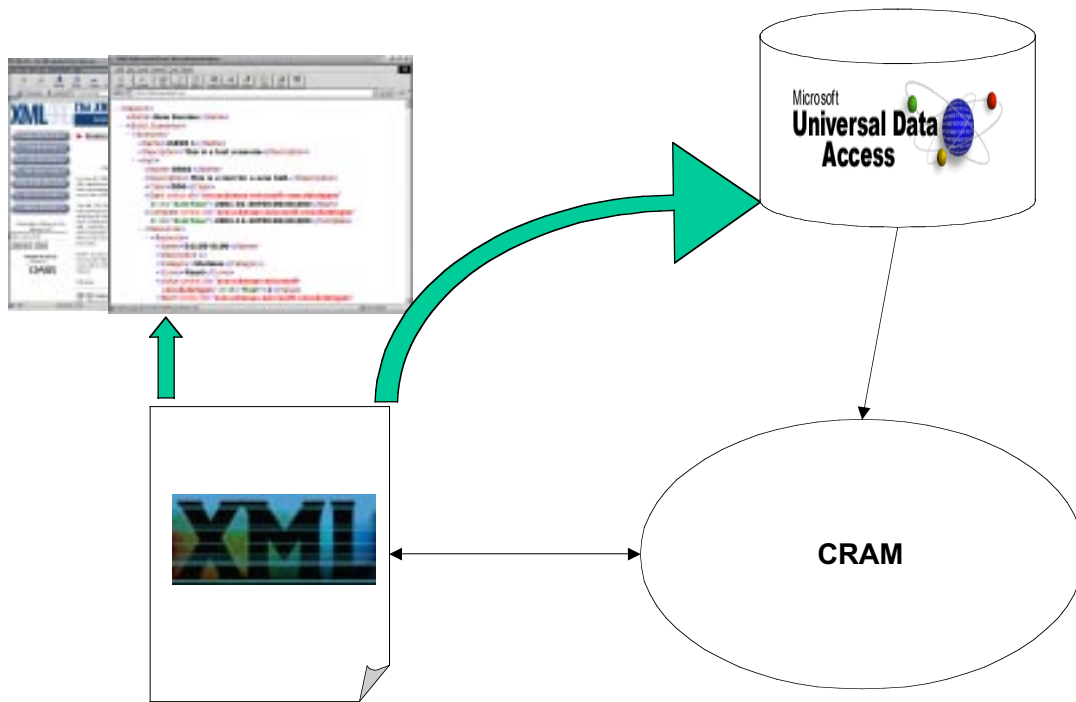
### 3.0 Development

Figures 3-1 and 3-2 depict the CRAM approach for data to enter and exit the model. It was important to be able to import data to the model from systems currently being utilized. Integration of legacy systems has historically been a significant obstacle in the development of new planning softwares. CRAM has been intentionally designed to exercise a unified modeling language. This ensures compatibility with current systems as well as future upgrades. Universal Data Access allows access to all Microsoft Office formats as well as SQL server, Oracle and others.

Figure 3-1



**Figure 3-2**

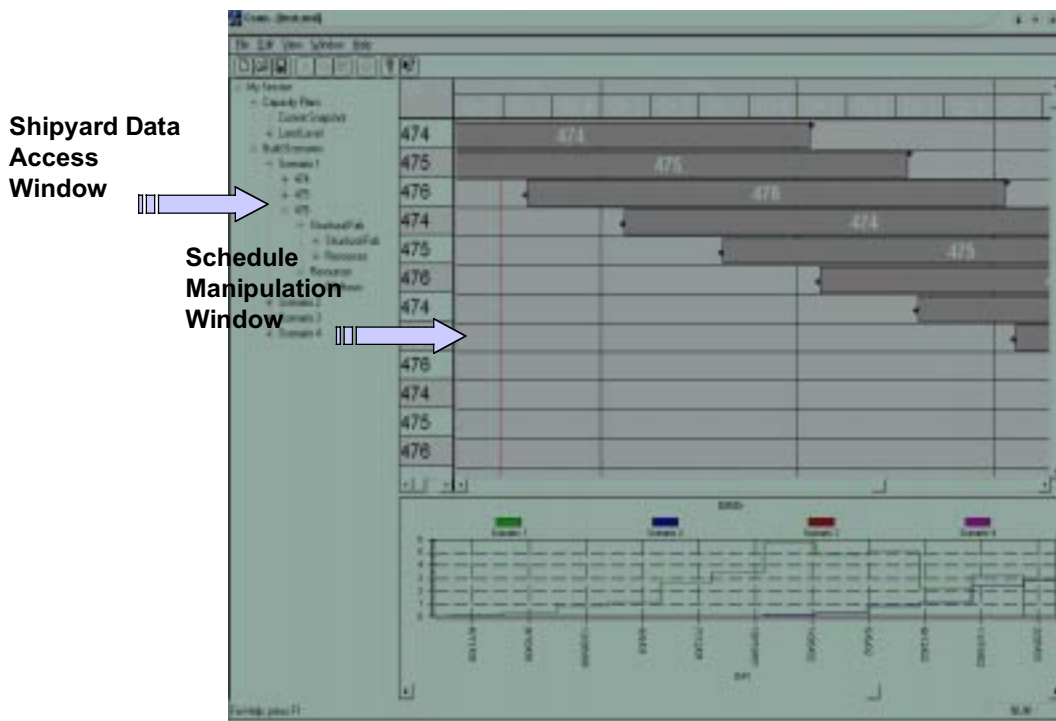


To extend its reach and compatibility, CRAM uses eXtensible Markup Language (XML). XML is well suited for both tabular and hierarchical data. It lets users define their own customized mark up languages for different classes of documents. XML is an increasingly popular and common language. It is web enabled allowing for simple, nearly instantaneous exchange of data.

CRAM has been developed as a high level generalized model which is effective for both capacity and resource analysis. The granularity, or level of detail, is determined by the user. Hence the user is enabled to compare build scenarios and capacity plans specific to any set of parameters.

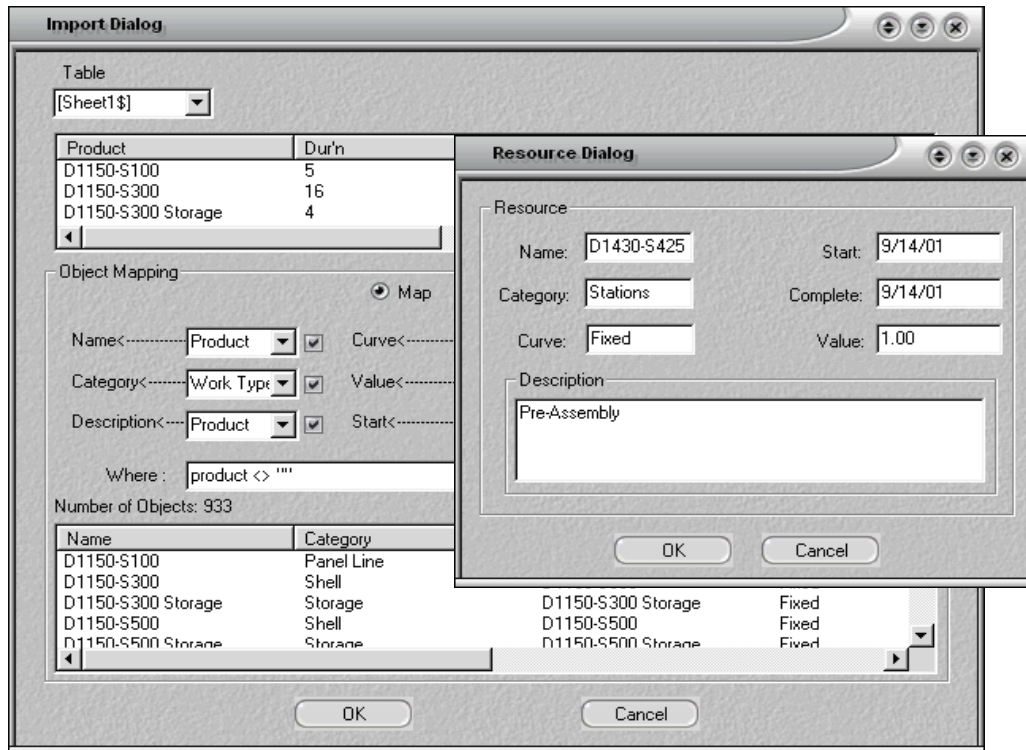
Figure 3-3 is an example of a screen view of CRAM looking at multiple hulls of data over time. Schedule and resource data can be accessed and manipulated in the shipyard data window and the schedule manipulation window. The graph at the bottom of the page can depict resource or station requirements as determined by the user.

**Figure 3-3**



After a CRAM model has been populated with data details can be adjusted through the dialog boxes, allowing the user to graphically see the potential effects of changes to schedule and resource plans. Figure 3-4 represents the dialog boxes within CRAM.

**Figure 3-4**



## 4.0 Implementation, Population, and Testing

Following a series of reviews of graphical user interface and core CRAM components, SURVICE Engineering provided an operational prototype of CRAM to Bath Iron Works for initial experimentation. The software was installed for Beta testing and implementation in the program planning process at BIW. The model was populated with a data set representing current programs in backlog.

Initial testing indicates that CRAM will meet all of the objectives identified as essential to success of the analysis model. As envisioned, CRAM will enable shipbuilders to evaluate alternative production plans and optimize their facility and resources. The newly operational Beta version of CRAM will undergo further testing and refinement.

For more information contact:  
National Shipbuilding Research and Documentation Center:

**<http://www.nsnet.com/docctr/>**

Documentation Center  
The University of Michigan  
Transportation Research Institute  
Marine Systems Division  
2901 Baxter Road  
Ann Arbor, MI 48109-2150

Phone: 734-763-2465  
Fax: 734-763-4862  
E-mail: [Doc.Center@umich.edu](mailto:Doc.Center@umich.edu)